b. a second generally circular solder pad formed upon the upper surface of the first substrate, the second generally circular solder pad having a center, and having said first predetermined diameter D, the center of said second generally circular solder pad being spaced from the center of said first generally circular solder pad by a predetermined spacing distance BL;

c. a solder bar pad of a first predetermined bar width BW formed upon the upper surface of the first substrate connecting said first circular solder pad to said second circular solder pad, the first predetermined bar width BW being less than the first predetermined diameter D;

d. a mass of low melting temperature reflowable solder having a solder bar volume VB formed over the first and second generally circular solder pads and over said solder bar pad to form said reflowable solder bar, the solder bar volume VB reaching a height H1 above the centers of said first and second generally circular solder pads, and reaching a height H2 above a midpoint of said solder bar pad, the mass of low melting temperature reflowable solder having a lowermost base region, the width of the lower most base region of the solder mass along the solder bar pad being substantially equal to solder bar pad width BW;

e. wherein the values for predetermined diameter D, spacing distance BL, predetermined bar width BW, and solder bar volume VB are selected in such manner that H1 and H2 are approximately equal.

REMARKS

This Amendment is accompanied by a Request for a Continued Prosecution Application pursuant to 37 C.F.R. §1.53(d), along with the required filing fee. This Amendment is also accompanied by a request for a two-month extension of time to respond to the final Office Action issued on May 24, 2002, and by the required extension fee for a large entity.

Applicant has amended apparatus claim 16 above to recite that the mass of reflowable solder formed over the first and second generally circular solder pads and over the solder bar

pad to form the reflowable solder bar is a mass of low melting temperature solder. Support for such additional limitation can be found in Applicants' disclosure at page 1, line 27, which describes a "63 Sn/37 Pb flip chip solder bump." U.S. Patent No. 5,796,169 (Dockerty, et al.), which has been applied by the Patent Examiner to reject the pending claims, discloses that 37/63 lead/tin alloy solder is a "low melting temperature solder."

It should be noted that this amendment of claim 16 is being made in the present application without prejudice to the presentation of method claims in a divisional patent application that are not specific to the melting temperature of the mass of reflowable solder.

Within the final Office Action, the Examiner maintained the prior rejection of pending claims 16-22 under Section 103 as being considered obvious from U.S. Patent No. 5,796,169 to Dockerty, et al. (hereinafter, "Dockerty") in view of four other cited patents. The Examiner contends that even high melting temperature solder is "reflowable" if heated to a high enough temperature.

However, as noted above, Applicants have further amended apparatus claim 16 above to recite that the mass of reflowable solder formed over the first and second generally circular solder pads and over the solder bar pad to form the reflowable solder bar is a mass of low melting temperature solder. In contrast, Dockerty specifically states that his support solder (16, 17 and 18) and solder balls (11) are formed of 90/10 lead/tin high melting temperature solder; see Dockerty, col. 3, lines 57-63, and col. 4, lines 51-65. Dockerty uses low melting temperature solder (20) only to attach the high melting temperature solder balls (11) and support solder (16, 17, 18) to underlying bond pads (4 and 15, respectively), as shown in Dockerty's Fig. 4. Likewise, when Dockerty's integrated circuit is to be joined to a mounting substrate (e.g., printed circuit board 1 of Fig. 5), low melting temperature solder paste is printed onto the circuit board contacts, the solder balls and support solder are inserted into such solder paste, and the assembly is then heated to the reflow temperature of the low melting temperature solder paste to form the final attachment of the solder balls and support solder to the printed circuit board.

Thus, Dockerty neither discloses nor suggests the formation of a reflowable solder bar having a mass of low melting temperature reflowable solder formed over first and second generally circular solder pads and over a connecting solder bar pad, in the manner claimed by claim 16 of the present application.

Applicants have already pointed out to the Patent Examiner that claim 16 recites that the solder bar pad over which the solder bar is formed has a bar width BW that is less than the diameter D of the first and second generally circular solder pads. Claim 16 has been further amended to recite that the mass of low melting temperature reflowable solder has a lowermost base region of a width, along the solder bar pad, substantially equal to solder bar pad width BW, and hence, also less than diameter D.

Dockerty, on the other hand, stresses the importance of matching the cross-section of the support solder (at least along one axis) to the cross-section of the solder balls; see, for example, col. 2, lines 18-22; col. 2, lines 32-36; col. 2, lines 48-51; and particularly, col. 2, lines 54-59. Thus, Dockerty clearly requires, as a "key structural feature", that the cross section of the support solder match the cross section of the solder balls. Rather than being a "matter of design choice", as argued by the Examiner, such dimensions are "a key structural feature", according to the Examiner's principal reference, Dockerty. However, Dockerty's requirement for such matching is directly contrary to the limitations of claim 16 requiring that the solder bar pad width BW, as well as the width of the base region of the solder mass overlying the solder bar pad, be less than the diameter D of the generally circular end pads.

The Examiner contends that it would have been obvious to modify the Dockerty solder support structure to make the cross-sectional bar width of support solder 16, 17, 18 less than the diameter of solder balls 11, and less than the diameter of the circular end points of such support solder structures. In this regard, the Patent Examiner relies upon U.S. Patent No. 6,091,155 (Jonaidi); U.S. Patent No. 6,050,832 (Lee); and 6,118,182 (Barrow).

Jonaidi is directed to BGA land patterns. The pads (14, 18) and connective traces (20) referenced by the Patent Examiner are not masses of solder; rather, they are printed conductive elements of a printed circuit board. Indeed, Jonaidi discloses that intermediate connecting

region 20 includes a "solder mask dam" specifically to prevent solder from diffusing between landing pad 18 and capture pad 14; see Jonaidi, col. 3, lines 19-29. Accordingly, the teachings of Jonaidi are inherently inconsistent with, and contradict, Dockerty's teachings of an elongated solder support structure.

The Patent Examiner has made specific reference to elements 233 and "pads" 228 and 230 of the cited patent to Lee. As shown in Fig. 3B of Lee, element 228 is not a "pad" but a via conductor; see Lee, col. 7, lines 1-2. Conductive traces 233 of Lee are clearly not solder masses, in contrast to solder balls 12 and 16, which clearly are solder masses.

Applicants have already pointed out the Examiner that Barrow, which does disclose a solder joint 26 spanning two contact pads 18, lacks any solder bar pad under the central solder mass 26. Moreover, Barrow teaches the use of rectangular solder end pads 18 when forming elongated solder structures, whereas both the claimed invention and Dockerty use circular end pads having the same radius of curvature as the solder ball pads. As noted by Applicants in the prior Amendment, application of Barrow's teachings to the Dockerty solder support structure would result in a solder mass having rectangular end pads and no underlying solder bar pad; more significantly, narrowing of the cross section of the solder mass in its central region between the end pads, as taught by Barrow, would violate the primary objective of Dockerty, namely, to keep the cross section along the axis of the support solder matched to that of any solder ball 11; see Dockerty, col. 4, lines 51-56.

Accordingly, it would not have been obvious to combine the teachings of Barrow with the Dockerty structure. Even if one attempted to do so, the resulting structure would not provide the structure recited by claim 16 as amended.

Again, the Examiner's comments regarding the Thompson patent are not understood, as Thompson does not form a solder bar structure. Solder joint 206 in Fig. 2c is circular.

For the reasons set forth above, Applicants submit that the invention defined by claim 16 as amended, and by claims 17-22 which depend therefrom, recite subject matter that would not have been obvious to those skilled in the art from the references cited by the Patent Examiner. Accordingly, Applicants respectfully submit that the present application is in

condition for allowance, which action is earnestly requested.

A marked-up copy of amended claim 16, wherein the text inserted above is underlined, is attached hereto.

Respectfully submitted,

CAHILL, SUTTON & THOMAS P.L.C.

Marvin A. Glazer
Registration No. 28,801

155 Park One
2141 East Highland Avenue
Phoenix, Arizona 85016
Ph. (602) 956-7000
Fax (602) 495-9475

Docket No. 5833-A-11CPA

Marked-Up Version of Claim 16
for U.S. Patent Appl. Serial 09/575,298

16. A reflowable solder bar formed upon an upper surface of a first substrate, the first substrate having a first electrical contact, said reflowable solder bar being adapted to join the first electrical contact to a second electrical contact on a second substrate, said reflowable solder bar comprising in combination:

a. a first generally circular solder pad formed upon the upper surface of the first substrate, the first generally circular solder pad having a center, and having a first predetermined diameter D;

b. a second generally circular solder pad formed upon the upper surface of the first substrate, the second generally circular solder pad having a center, and having said first predetermined diameter D, the center of said second generally circular solder pad being spaced from the center of said first generally circular solder pad by a predetermined spacing distance BL;

c. a solder bar pad of a first predetermined bar width BW formed upon the upper surface of the first substrate connecting said first circular solder pad to said second circular solder pad, the first predetermined bar width BW being less than the first predetermined diameter D;

d. a mass of <u>low melting temperature</u> reflowable solder having a solder bar volume VB formed over the first and second generally circular solder pads and over said solder bar pad to form said reflowable solder bar, the solder bar volume VB reaching a height H1 above the centers of said first and second generally circular solder pads, and reaching a height H2 above a midpoint of said solder bar pad<u>, the mass of low melting temperature reflowable solder having a lowermost base region, the width of the lower most base region of the solder mass along the solder bar pad being substantially equal to solder bar pad width BW</u>;

e. wherein the values for predetermined diameter D, spacing distance BL, predetermined bar width BW, and solder bar volume VB are selected in such manner that H1 and H2 are approximately equal.